Chapter 2
Water Resources

Chester Morse Reservoir

SPU's Water Resources business area focuses on the programs and projects that ensure SPU's customers and instream resources will have sufficient water to meet their needs, both in the present and for the foreseeable future. One important function of the business area is the real-time management and operation of mountain reservoir and river facilities for municipal use while meeting instream flow requirements and managing floods. Water resource concerns also include forecasting future water demands and evaluating current supply capacity and the need for future new supply sources and water rights. Future supplies can include traditional sources, such as surface water and groundwater, water "supplied" by conservation efforts, reclaimed water projects, and desalination. The business area also addresses issues related to dam safety and infrastructure maintenance and improvements.

SPU has the water supply necessary to meet needs now and well into the future.

Chapter 2 describes how SPU is prepared to meet water demands in the foreseeable future even with the uncertainties surrounding the potential impacts of future climate change and population growth.

2.1 Policies

SPU has developed water resource policies related to who it serves, its regional role and partnerships, planning for uncertainty, supply reliability, and resource selection. These policies update, revise, or replace policies from the *2001 Water System Plan*.

2.1.1 Service Area Policy

The first priority of SPU's water line of business is to ensure reliable, high-quality drinking water service to its existing retail and wholesale customers. From time to time, however, SPU is asked to provide wholesale service to areas that it does not presently serve. SPU continues to be willing to serve new wholesale customers where it is feasible to extend service without compromising its ability to serve existing customers.

This revised policy resulted from the need to clarify what conditions would need to be met for SPU to provide new service. The policy maintains the same water service area and gives greater flexibility in providing service to new wholesale customers by allowing the City to negotiate the conditions of service individually with each potential wholesale customer. The policy neither over-extends nor revokes any of SPU's commitments and therefore does not increase the utility's exposure to potential risks.

Policy Statement

Continue providing service within the service area boundary as defined in the 2001 Water System Plan*, allowing for new customers within that area at SPU's discretion.*

1. *Consider extending service to new wholesale customers when the following conditions are present:*
   a. *Compliance of the proposed new service with SPU water rights, legal agreements, and any applicable state regulatory constraints.*
   b. *Benefits, or at least has no net adverse impact, to existing retail and wholesale customers based on triple-bottom-line analysis.*
   c. *Compatibility of the proposed new service with the County comprehensive and land use plans.*
   d. *Willingness of the proposed new wholesale customer to enter into a contract with the City that defines the terms and agreements of service.*
2. *Favor service to new wholesale customers where public health is at risk, regional efficiencies exist, or environmental benefits are to be gained.*
3. *Encourage new wholesale providers to participate on the Seattle Water Supply System Operating Board to help guide policy and operational matters as they affect the Seattle regional water supply system.*

The Seattle Water Supply System Operating Board is comprised of wholesale customers and Seattle representatives, and has authorities described in the wholesale water contracts.

2.1.2 Regional Role and Partnerships Policy

Regional growth has spread throughout the central Puget Sound area such that development between Everett and Tacoma is nearly continuous. As a result, the potential and need for regional water planning and interties between neighboring water systems has steadily increased, and utilities have increased coordination to efficiently address both normal and emergency water supply conditions and the potential impacts of climate change. Over the years, SPU has been a leader in regional forums, such as the Central Puget Sound Water Suppliers' Forum, and active in other regional organizations, such as the regional water associations.

The revised policy on SPU's regional activities reflects the utility's proactive role as both a service provider and regional leader. While collaborative planning may require long time frames and introduce or interject issues from other utilities, the implementation of this policy has a number of benefits that arise from working collaboratively with others. These benefits outweigh the disadvantages since the policy is designed to protect SPU customers when seeking solutions that benefit the region as a whole.

Policy Statement

Be a leader in seeking regional cooperation and efficiencies that benefit the customers of SPU, other water utilities, and the environment.

1. *Continue to engage actively in collaborative drinking water planning efforts that encompass the tri-county area of Snohomish, King, and Pierce counties.*
2. *Manage and operate, under normal and unusual conditions, in coordination with other water utilities in the tri-county area.*
3. *Explore cooperative or conjunctive opportunities with other utilities in the tri-county area that maximize efficiency, drinking water quality, and reliability while being environmentally sensitive.*
4. *Support efforts to ensure availability of drinking water supplies within the region.*
5. *Share knowledge and expertise with other water utilities in the region.*

2.1.3 Planning for Uncertainty Policy

There is significant uncertainty concerning both water supply and water demand that affects how SPU conducts water supply planning. Large shifts in demand can occur, for example, as a result of wholesale customers purchasing more or less water from Seattle than expected. Similarly, changes in legal requirements or an unusually severe drought can affect the water supply available from existing systems. In addition, uncertainties such as potential impacts of future climate change and the time required for source development need to be considered. In the face of uncertainty, SPU has developed a policy that sets the direction for how SPU will plan to meet the long-term water supply needs of its retail and wholesale customers, while meeting the needs of instream resources.

In the past, uncertainty surrounding potential new supplies caused SPU to engage in "parallel planning" of multiple supply and demand management options. While this strategy may have resulted in somewhat higher short-term costs, its goal was to reduce the risk of pursuing a single supply option which might subsequently have ended up being impossible to implement. SPU's new policy has a broader approach than that used in the past to take into account the range of future possibilities that now exists. It incorporates a small part of the old Level of Service policy concerning the timing and sizing of new facilities by attempting to capture how that planning will be done in an uncertain world. This policy allows for the possibility of developing a supply source prior to the cross-over point of supply and demand if an analysis of risk and costs shows this to be sensible. While the policy provides direction for utilizing scenarios to plan for a wide range of possible futures, it carries forward the parallel planning of multiple new sources as has been done in the past.

Policy Statement

Base supply investment strategies on future outlooks for supply and demand that incorporate an evaluation of uncertainties using the best available analytical tools.

1. *Consider investing simultaneously in the planning-level or preliminary engineering design stages of multiple sources to ensure sufficient supply is available to meet demand when it is needed in the future.*
2. *Implement or construct new sources prior to the supply/demand cross-over point when prudent for reducing risk or cost.*
3. *Address potential impacts of long-term climate change on water supply and demand in developing supply investment strategies based on the most current knowledge available and a wide range of climatic conditions.*
4. *Factor in needed emergency reserves when evaluating available water sources and alternative supply investment strategies.*
5. *Re-evaluate the supply investment strategy at least every six years, and adjust it, as needed, based on new information.*

2.1.4 Supply Reliability Policy

Water supply reliability underlies SPU's planning efforts to meet future demand and sets expectations for how dependable the water supply will be under varying hydrologic conditions. This policy reflects how SPU will provide service to its customers and maintain stream flows to protect fish. The supply reliability policy also provides guidance on the approach the utility will take in meeting water demands during extremely low water supply conditions while ensuring adequate stream flow for fish habitat.

The revised policy reflects the increasing importance of factoring in the water supply needs of fish and reflects SPU's increased emphasis on following the principles of asset management. The policy provides the new direction for incorporating emerging information regarding the ramifications of potential future climate change for drinking water supply. Finally, contingency planning is further defined in this revised policy to reflect the importance of maintaining emergency supplies.

Policy Statement

Plan to meet full water demands of "people and fish" under all but the most extreme or unusual conditions, when demands can only be partially met.

1. *Take into account reductions in demand resulting from demand management when forecasting water demands for people.*

The 98% standard is used to determine the amount of water available in all but the driest 2% of years.

2. *In forecasting water demands for fish, include water that is needed to meet regulatory requirements and provisions of legal agreements, and to maintain healthy ecosystems based on best available science that prove beneficial in a triple-bottom line analysis.*

3. *Use a 98% engineering planning standard for determining long-term yield from water supplies, which differs from the approach used for evaluating available supplies on a year-to-year basis.*

"Conjunctive use" refers to the combined use of multiple water supply sources to optimize resource use and minimize adverse effects of using a single source.

4. *Include operational requirements associated with flood management, as well as increments in supply related to conjunctive use of SPU supply sources, when determining long-term yield.*

5. *As understanding of regional climate change and variability advances, continue to factor it into long-range demand and supply analysis.*

6. *Maintain a contingency plan that guides utility and customer actions during low water conditions in a way that strives to minimize impacts to people and fish.*

7. *Maintain backup supplies as a tool for managing supply in years with unusually low water conditions.*

2.1.5 Resource Selection Policy

Meeting future water demands for a growing population ultimately involves the selection of specific water resource projects and/or implementing additional conservation. To provide guidance on its resource selection process and criteria, SPU has revised the previous resource selection policy to incorporate asset management principles and selection criteria that were approved by the Seattle Water Supply System Operating Board. This policy reiterates SPU's commitment to sustainable water supply and minimizing environmental impacts while meeting the drinking water needs of future generations. It repeats the previous policy's emphasis that reductions in water use through conservation can be equivalent to increasing supply by the same amount, but also recognizes that conservation may be justified by reasons other than meeting demand, such as meeting legal requirements, environmental stewardship, and customer service expectations. The new policy explicitly includes reclaimed water as an alternative source option and favors regional approaches to water issues, such as implementing conservation on a regional basis and creating interties to more efficiently supply the region with water.

Policy Statement

In planning to meet future customer demand, select new sources of supply from all viable options, including conservation programs, improvements to system efficiencies, use of reclaimed water, and conventional supply sources, based on triple-bottom-line analysis.

1. *Consider conservation programs, pricing, and system efficiency improvements as a way to meet future supply needs in addition to what may be implemented to meet other objectives.*

    a. *Meet or exceed state requirements for conservation programs and avoid lost opportunities.*

b. Evaluate conservation programs using the same method as evaluating other sources of water, where environmental and social benefits are included in the triple-bottom-line analysis.

2. Seek opportunities for regional efficiencies.

3. Explore reclaimed water projects and evaluate them based on triple-bottom-line analysis in comparison to other source options.

4. Assess new supply options using source selection criteria approved by the Seattle Water Supply System Operating Board.

5. Select new water supply resources with meaningful public participation.

2.2 SERVICE LEVELS

In managing its water resources, SPU has established service levels that are consistent with its regulatory requirements and environmental commitments. In particular, SPU's water resources service levels give emphasis to instream flows and conservation. Table 2-1 summarizes these service levels.

Table 2-1. SPU's Service Levels for Managing Water Resources Assets

Service Level Objective	Service Level Target
Meet the environmental requirements of our water rights and water supply operations.	Meet instream flow requirements and performance commitments in tribal, regional, state, and federal agreements and permits.
Meet water use efficiency goals to ensure wise use and demonstrate good stewardship of limited resource.	Achieve water conservation goals: - Save 14.5 mgd (peak season) from 2000 to 2010. - Save additional 15 mgd (average annual) from 2011 to 2030. - Meet the Initiative 63 Settlement Ordinance requirements.

Each service level is discussed in further detail below.

2.2.1 Instream Flow Requirements

In operating its surface water supply sources, SPU is obligated to meet instream flow requirements on the Cedar and South Fork Tolt

Rivers to protect fisheries resources and aquatic habitat. On the Cedar River, instream flow management is governed by the Cedar River Instream Flow Agreement (IFA), a component of the Cedar River Watershed Habitat Conservation Plan (HCP). The IFA specifies a guaranteed flow regime as measured at the USGS stream gage below the Landsburg Dam. This regime includes normal and critical minimum flow levels as well as additional supplemental flows or blocks of water at certain times of year that are linked to real-time hydrologic conditions and biological need. The agreement also specifies limitations for changing flow rates (i.e., “down-ramping”) within certain flow ranges, and specifies minimum releases from Chester Morse Lake into a short bypass reach of the river between Masonry Dam and the Seattle City Light Cedar Falls hydroelectric facility. During many times of the year, stream flows exceed the levels required to meet the guaranteed flow regime and municipal diversions. The HCP provides funding for studies to help guide the management of this additional water in collaboration with the interagency Cedar River Instream Flow Commission, which oversees the implementation of the Cedar River instream flow management program.

For the South Fork Tolt River, instream flow requirements are specified in the 1988 South Fork Tolt River Hydroelectric Project Settlement Agreement that was negotiated and committed to as part of the Federal Energy Regulatory Commission (FERC) licensing process for the Seattle City Light South Fork Tolt hydroelectric facility. This agreement specifies normal and critical minimum instream flow levels at the USGS stream gauge on the South Fork Tolt River near Carnation. Limitations on down-ramping flow rates are also included in the agreement. The interagency Tolt Fisheries Advisory Committee oversees the implementation of the instream flow management program and associated mitigation projects.

SPU’s performance in meeting this service level is tracked in semi-annual and annual compliance reports. To date, SPU has almost always met its instream flow obligations; only a few minor noncompliance incidents have occurred, and actions have been taken to prevent reoccurrences.

2.2.2 Water Conservation

SPU and the Operating Board have made a strong commitment to water conservation. That commitment is reflected in SPU’s conservation level of service, which calls for increased efficiency in the use of water over time to ensure wise use and demonstrate

SPU is committed to being a leader in water conservation.

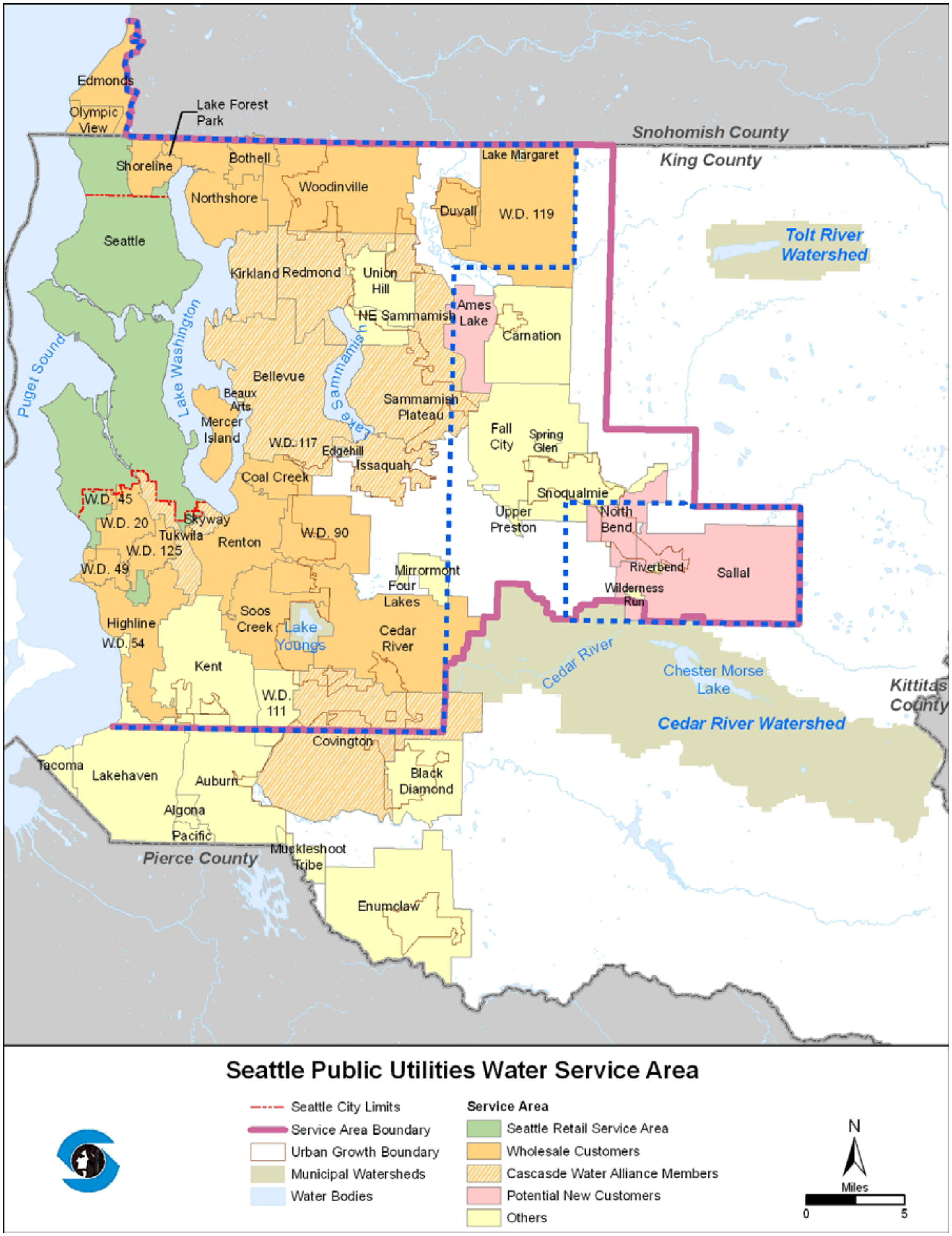
good stewardship of limited resources. Specific conservation objectives are tied to City ordinances and conservation programs, discussed later in this chapter. Evaluations of SPU's conservation goals and its performance in meeting them are conducted each year and documented in annual reports. SPU's most recent annual report is included in the Water Conservation Plan 2007-2012 appendix to this plan. To date, SPU is on track to meet its conservation goals.

2.3 EXISTING SYSTEM AND PRACTICES

The total population living in the area currently served by SPU and its wholesale customers in King and southwest Snohomish County is about 1.45 million. Since some of SPU's wholesale customers have other water supplies, it is estimated that approximately 1.2 million persons use SPU water on a regular basis. To provide water to the people and businesses in its service area, SPU operates and maintains supply facilities associated with its surface water sources and well fields. This section provides an overview of the service area to which SPU provides water service. The section also summarizes the City's water rights and the quantity of water that can be reliably provided to the service area, or the firm yield of its supply sources. SPU's water demands, including the non-revenue component of demand, are then summarized. The City's water conservation programs are described, and the section concludes by describing the operations activities employed to manage instream flows and maintenance activities for the water supply facilities.

2.3.1 Service Area Characteristics

Besides serving retail customers, SPU provides wholesale water to area cities and water districts, who in turn deliver water to their customers' taps. Figure 2-1 shows these different customer types and service area boundaries. SPU's service area maintains the same water service area that has been in place since the *1980 Water Complan*, which, in general, includes the city of Seattle, the suburban areas immediately to the north and south, and similar areas extending east of Lake Washington to slightly beyond North Bend. The population within the Service Area has steadily grown since the *2001 Water System Plan*.



* Note: The place of use of the Cedar River water claim is being revised to the entire service area as part of this *2007 Water System Plan*.

Figure 2-1. SPU's Water Service Area*

Changes in Demographics

Actual growth in population, number of households, and employment through 2005 has differed from the *2001 Water System Plan* forecast, mostly because of the economic recession in the first half of the decade. Overall, population in the area served by SPU grew at about half the rate forecast in the *2001 Water System Plan*. While employment was projected to increase almost 8 percent between 2000 and 2005, it actually shrank by more than 5 percent over that period. However, after the 2000 census results were released, it became apparent that the year 2000 estimates of population and employment in the *2001 Water System Plan* were too low. Table 2-2 summarizes these demographic changes and compares the current data with forecasts and estimates from the *2001 Water System Plan*.

Table 2-2. Demographic Changes*

Year	2001 WSP Data	Current Data	Difference
Population			
2000	1,209,528[E]	1,238,645[C]	29,117
2005	1,261,870[F]	1,267,419[E]	5,548
Percent Growth	4.3	2.3	
Households			
2000	523,931[E]	524,812[C]	881
2005	562,840[F]	547,469[E]	−15,371
Percent Growth	7.4	4.3	
Employment			
2000	888,750[E]	952,618[C]	63,862
2005	956,556[F]	901,245[E]	−55,311
Percent Growth	7.6	−5.4	

Data sources: C=2000 Census data; E=Estimate; F=Forecast

* Note: Population data from the *2001 Water System Plan* did not include Covington, Issaquah, and Sammamish Plateau. Also excluded from the *2001 Water System Plan* population data were Edmonds, Lake Forest Park, and Renton, all of which purchase only negligible amounts of water from SPU. For comparison, current data reflect these same areas.

Retail Customers

SPU delivers water directly to a population of more than 628,000 through more than 180,000 service connections, approximately 32,000 more people than indicated in the *2001 Water System Plan*. This increase has resulted from increased population density from development of vacant property and redevelopment of property to higher densities. Since the *2001 Water System Plan*, significant redevelopment has occurred in the City's six urban centers. The area between the north end of downtown and the south tip of Lake Union has been largely rezoned as "Seattle mixed," which allows for residential and commercial development. South Lake Union was designated as Seattle's sixth urban center in 2004.

Wholesale Customers

SPU's wholesale customers currently serve a total population of more than 850,000; about 600,000 of the people living in these areas actually use water from SPU on a regular basis. Non-SPU water is supplied to the other 250,000 customers by these wholesale customers. Current Seattle wholesale customers, listed in Table 2-3, include 21 municipalities and special purpose districts.

Table 2-3. SPU Wholesale Water Customers

Name of Customer	
Bothell, City of	Renton, City of[2]
Cascade Water Alliance (CWA)[1]	Shoreline Water District[3]
Cedar River Water and Sewer District[3]	Soos Creek Water and Sewer District[3]
Coal Creek Utility District[3]	Water District No. 20[3]
Duvall, City of	Water District No. 45[3]
Edmonds, City of[2]	Water District No. 49
Highline Water District[3]	Water District No. 90
Lake Forest Park Water District[2]	Water District No.119
Mercer Island, City of[3]	Water District No.125[3]
Northshore Utility District[3]	Woodinville Water District[3]
Olympic View Water and Sewer District[3]	

1 Individual members of the Cascade Water Alliance are the cities of Bellevue, Issaquah, Kirkland, Redmond, and Tukwila, and Covington Water District, Sammamish Plateau Water and Sewer District, and Skyway Water and Sewer District.

2 Purchases negligible amounts of water from SPU.

3 Represented by Seattle Water Supply System Operating Board.

The wholesale customers' service areas have experienced more rapid population growth than SPU's retail service area. The significant growth in the number of persons served by SPU wholesale customers reflects the region's continued development of previously undeveloped land. Development occurring in the commercial, high technology, industrial, multifamily, and supporting governmental and institutional sectors has also had an impact. This is particularly true in the more established areas of Bellevue, Redmond, Renton, Kirkland, and southwest King County, where the population and employment densities have become more similar to that of Seattle.

Since 2001, SPU and most of its wholesale customers have signed new wholesale water contracts to replace the 1982 contracts that were to expire on December 31, 2011. SPU now provides service to its wholesale customers under three contract types:

- Full Requirements Contracts. Since 2001, SPU has negotiated and is implementing long-term, full-requirements water supply contracts with nine of its wholesale customers. These new contracts extend to 2060, establish wholesale water rates, and include a provision for an operating board to address issues related to the Seattle water supply system. The wholesale customers also have the first right of refusal for contract renewal after the 60-year contract ends.

- Partial Requirements Contracts. SPU has also signed new partial-requirements contracts with two of its wholesale customers, Highline Water District and Olympic View Water and Sewer District. These utilities have their own sources of supply with which they meet a portion of their demand, depending on Seattle for the rest. Contract provisions pertaining to expiration dates, wholesale rates, Operating Board membership, etc., are identical to the full requirements contracts.

- Block Contracts. In 2003, SPU signed long-term contracts for specified amounts of water ("block contracts") with the Cascade Water Alliance (CWA), whose members are listed above in a footnote to Table 2-3, and Northshore Utility District. SPU's contract with CWA is a declining block contract that limits annual CWA purchases from SPU to an average 30.3 million gallons per day (mgd) through 2023, after which the block volume begins to decline. The block will be reduced by 5 mgd in 2024 and by another 5 mgd in 2030. Additional 5-mgd reductions will occur every 5 years thereafter through 2045, leaving a final block of 5.3 mgd. As a new, independent wholesaler of water, CWA chose to not participate on the Operating Board.

Northshore's block contract is for 8.55 mgd on an average annual basis for the duration of the contract, which is expected to meet all the district's water supply needs. Northshore provides water directly to its retail customers and participates on the Operating Board.

2.3.2 Water Demand

For most of Seattle's history, water consumption increased along with its population. However, that link was broken around 1990 when consumption reached its highest level. Since then, water consumption has steadily declined due to various forms of conservation despite continued population growth. By 2005, consumption was lower than it had been since 1964.

Historical Water Consumption

Since 1990, water consumption has steadily declined despite population growth.

Figure 2-2 displays Seattle system water consumption and population since 1975. While population has steadily risen since 1975, water demand leveled off during the 1980s before dropping off sharply in 1992 due to a severe drought and mandatory curtailment measures. Since then, the combined effects of higher water rates, the 1993 state plumbing code, conservation programs, and improved system operations kept both billed and total consumption significantly below pre-drought levels. Water consumption has further declined in the last 5 years due to additional conservation efforts represented by the regional 1% Conservation Program, significant increases in water and sewer rates[1], and an economic slow-down. Since 1990, consumption has decreased about 40 mgd (24 percent) while population increased by 13 percent.

Peak water demand has fallen even more than annual average demand since the 1980s. In the 1980s, hot summer weather could produce peak day consumption of over 325 mgd. However, during an extremely hot summer in 1994 when temperatures reached 100 degrees, peak day consumption was only 270 mgd. Ten years later, peak day consumption barely reached 250 mgd during the two very hot, dry summers of 2003 and 2004. Peak month consumption has also been trending downwards over the past twenty plus years, though not as steeply as peak day consumption.

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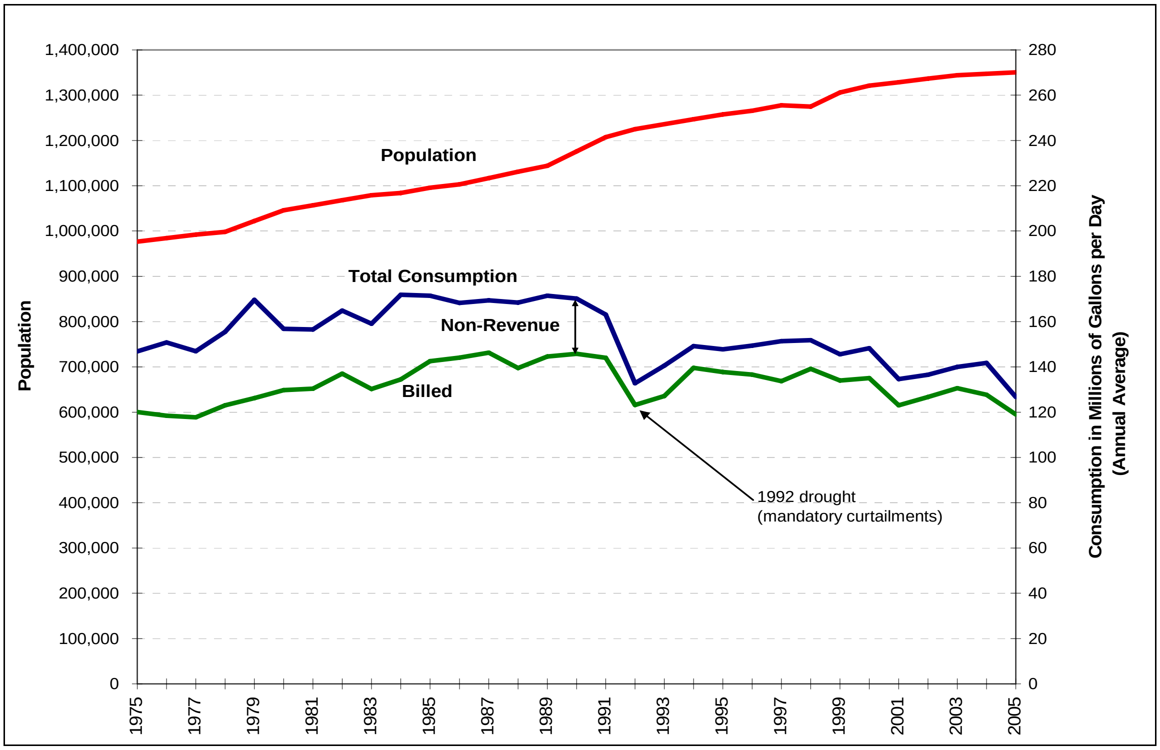
[1] Seattle's sewer rates are based, in part, on water use, so that using less water may result in a lower sewer bill, thereby increasing a retail customer's incentive to conserve water.



*Note: Issaquah, Sammamish Plateau, and Covington are not included in historic data because they did not become customers until 2004 when contract with CWA was signed.

Figure 2-2. Population Growth and Water Consumption from SPU Sources, 1975 – 2005*

Before the 1992 drought, peak month consumption averaged over 250 mgd. Since then, the average has been around 205 mgd.

Non-Revenue Water

Non-revenue water is calculated by subtracting total metered water sales - both retail and wholesale - from total water diversions from SPU's water supply sources.

SPU's system non-revenue water is calculated by subtracting total metered water sales−both retail and wholesale−from total water diversions. Decades ago, Seattle had a considerable amount of non-revenue water. Between 1975 and 1984, non-revenue water averaged about 30 mgd, almost 20 percent of total water consumption. In 1985, Seattle began taking steps to reduce the amount of non-revenue water used in operating the system. The in-city reservoirs with the highest leakage rates were relined and the amount of water used for flushing Green Lake was decreased. Average non-revenue water dropped to 26 mgd (representing 15 percent of total water consumption) over the period 1985-1990. More efficient in-town reservoir washing practices and the elimination of in-town reservoir overflows related to turbine use brought non-revenue water down even further in 1991. Finally, the 1992 drought prompted additional changes in practices. Green Lake flushing and reservoir overflowing were completely eliminated, while reservoir improvements, such as joint sealing and relining, continued to be made. As a result, non-revenue water was reduced to just 10 mgd, or 7 percent of total consumption.

Since 1992, non-revenue water has remained relatively flat, fluctuating mostly between 10 and 13 mgd and averaging 11 mgd or about 8 percent of total consumption. Some in-town reservoir overflowing was resumed in 1996 for water quality reasons with episodes of significant overflowing taking place in 1997 and 2004. SPU has installed drain line meters on two of its four remaining open reservoirs to measure the quantity of overflowing water. As the remaining open reservoirs are covered or replaced, overflowing will be substantially reduced, as will the need to empty the reservoirs for cleaning. Table 2-4 reflects SPU's best current estimates of the components of non-revenue water.

Table 2-4. Components of Non-Revenue Water and Estimated Magnitudes

Total Non Revenue Water	10.0 mgd
System Operations	2.0 mgd
Reservoir Overflowing	1.0 mgd
Reservoir Draining/Cleaning	1.0 mgd
Water Main Flushing	<0.1 mgd
Public Uses	0.3 mgd
Construction	<0.1 mgd
Sewer flushing, fire fighting, street-cleaning, etc.	0.2 mgd
Meter Inaccuracies[1]	3.4 mgd
System Losses	4.3 mgd
Measured Losses (Reservoir Leaks/ Evaporation)	0.3 mgd
Unmeasured Losses (Pipeline Leaks and Other)[2]	4.0 mgd

[1] All the above categories except meter inaccuracies were estimated by water service and operations staff. Meter inaccuracies were calculated by subtracting the estimates for all other types of non-revenue water from total non-revenue water. To the extent the estimates for all other types of non-revenue water are (on average) too low, the estimate of unmeasured losses will be too high, and vice versa.

[2] Based on recent theoretical analysis of system leak rates. See Distribution System Renewal Strategy Technical Memorandum, March 2006, in the Appendices.

2.3.3 Water Conservation Programs

Low flow appliances help conserve water

The City is currently pursuing two ongoing programs or initiatives to encourage conservation both regionally and locally:

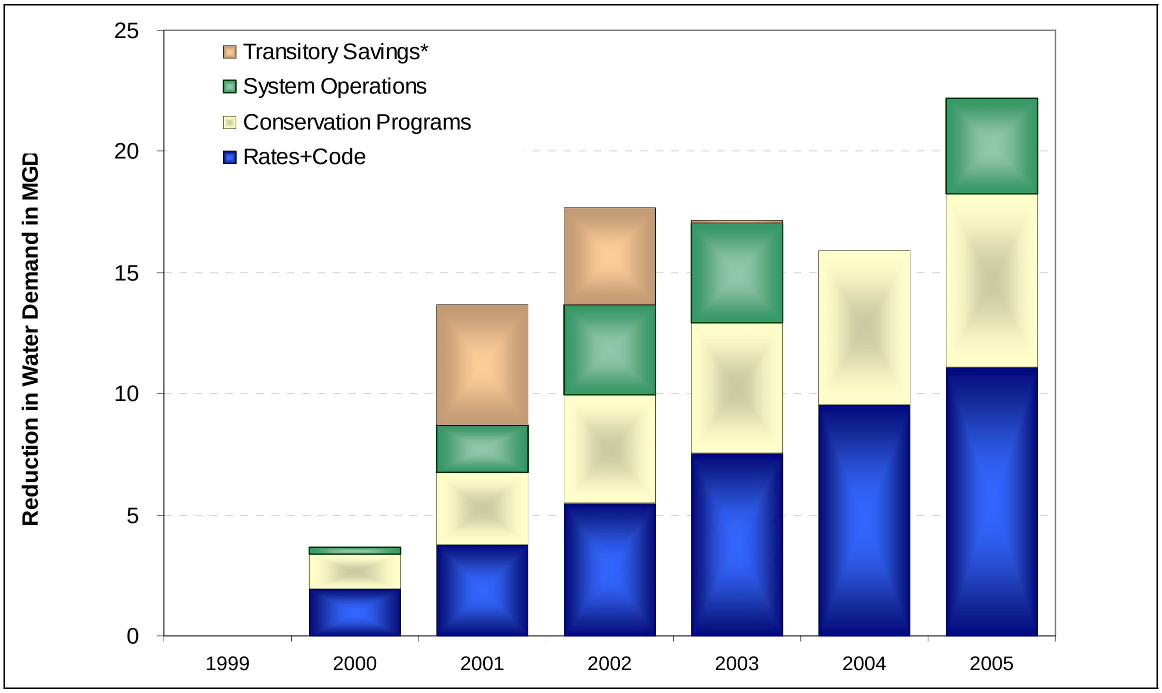
- 1999 1% Regional Water Conservation Program (1% Program)
- Initiative 63 Settlement Ordinance (I-63 SO)

The motivation for the City's 1% Program was the 1997 demand forecast that predicted that without conservation, Seattle would need a new source of supply by 2013. The long-term goal was to keep water demand flat through 2010 despite 10 years of forecasted population growth. The 1% Program was expanded to include the entire SPU service region in 2000 and is sponsored by the Saving Water Partnership, which includes Seattle and most of Seattle's wholesale customers. Performance targets for the 1% Program from 2000-2010 include reducing annual per capita consumption by 1 percent per year and achieving a cumulative total of 14.5 mgd peak season savings, or approximately 11 mgd on an annual basis. The 1% Program plan is included in the Water Conservation Plan 2007-2012 appendix to this plan.

The City of Seattle adopted the I-63 SO in 2001 (Ordinance 120653), which committed the City to pursue conservation beyond the 1% Program in the SPU direct service area and to focus on low-income housing conservation assistance by establishing the Everyone Can Conserve Program. From 2001 through 2005, that program saved an estimated 0.4 mgd of annual average water savings by retrofitting a total of 14,087 housing units with water conservation fixtures and equipment. The I-63 SO directed SPU to provide 3 mgd of water savings in the Seattle retail service area above and beyond the 1% Program by 2010. The I-63 SO is being implemented through the Everyone Can Conserve Program, through increased system efficiencies resulting from the accelerated in-town reservoir replacement program, and other cost-effective measures.

Between 1999 and 2005, an estimated cumulative average annual savings of 22 mgd was achieved.

Figure 2-3 shows cumulative water savings from various sources, including the 1% Program, I-63 SO, efficiencies in system operations, changes to the plumbing code, pricing, and transitory savings. Between 1999 and 2005, an estimated cumulative average annual savings of 22 mgd was achieved.



*Note: Transitory savings are water reductions from drought curtailments and carry-overs in subsequent years.

Figure 2-3. Cumulative Water Savings from Conservation, in Average Annual mgd, 1999-2005

2.3.4 Infrastructure

To meet the water demand of its customers, SPU operates and maintains two surface water sources of supply, each of which has associated infrastructure (such as reservoirs, dams, pump stations, and pipelines). This section describes the capacities of each of Seattle's water sources and provides information concerning the City's water rights and firm yield. The 2006 agreement between the City and the Muckleshoot Indian Tribe is also discussed.

Supply Sources

Seattle obtains approximately 70 percent of its raw drinking water supply from the Cedar River and most of the remaining 30 percent from the South Fork Tolt River, as described in the *2001 Water System Plan*. Seattle's two well fields are available to provide peak season and emergency supply. Additional information about each supply source is included below. The Cedar Supply is discussed at greater length because of its greater complexity.

Cedar River. The Cedar River Municipal Watershed is located in the Cascade Range within southeast King County. The watershed contains the 1,680-acre Chester Morse Lake, formed behind a Masonry Dam. The lake serves as a reservoir for 15.8 billion gallons (48,500 acre-feet) of high-quality water above its natural gravity outlet.

The Chester Morse Lake pumping plants, two sets of barge-mounted pumps, each with the capacity to pump 120 mgd, are stationed year-round on the lake and can be anchored near its outlet to draw additional water from below the outlet level during drought emergencies. The pumping plants can also augment the gravity flow capacity of the outlet channel during normal supply conditions. Changes to the pumping facilities, outlet channel, and associated discharge dike have been made since 2002 to restore flow capacity and improve reliability of the system.

Water stored in Chester Morse Lake flows downstream to the Landsburg Diversion Dam and fish passage facility, which is located about 14 miles downstream from the Masonry Dam. Here, water is diverted through pipelines to Lake Youngs Reservoir. Lake Youngs Reservoir, with a useable storage capacity of approximately 1.5 billion gallons (4,600 acre-feet), provides additional storage and regulates flows to the Cedar Treatment Facility.

Some of the Cedar River source water is lost from the Masonry Pool, the portion of the reservoir between the Overflow Dike and Masonry Dam, via seepage into a moraine on the Pool's northern bank. Water leaks out of the Masonry Pool mostly in the spring and early summer, when water is relatively abundant, fills an underground "reservoir" or aquifer, then returns to the river in the summer, when it provides a water supply benefit in the critical fall season in the extreme dry years. About 75 percent of the water that leaks from Masonry Pool is "stored" in this way and finds its way back to the Cedar River, while the remainder ends up in the Snoqualmie River basin. The system is operated to minimize the impacts of this seepage loss.

South Fork Tolt River. The South Fork Tolt River Municipal Watershed is located about 13 miles east of Duvall in King County. The South Fork Tolt Reservoir, which went online in 1964, provides 18.3 billion gallons (56,160 acre-feet) of storage. Water from this reservoir is conveyed to the Tolt regulating basin and the Tolt Treatment Facility.

The Seattle Well Fields can be artificially recharged to increase production.

Seattle Well Fields. In addition to the major surface water supplies, Seattle operates two small well fields in the City of SeaTac to provide additional peak season capacity and emergency supply, as needed. The Riverton well field has two wells, and the Boulevard Park well field has one well. In total, the three wells can supply up to 10 mgd for approximately four months. The well fields are naturally recharged, but the wells can also be artificially recharged using a method known as aquifer storage and recovery (ASR), if needed. When used, ASR injects treated water from the Cedar River into the production wells to supplement natural recharge into the aquifer.

Water Rights

Seattle holds various water rights for use of water from the Cedar River, South Fork Tolt River, and Seattle Well Fields. Also, Seattle has water right applications on file with the Washington State Department of Ecology (Ecology) for potential future sources of supply, including for the North Fork Tolt River, Snoqualmie Aquifer, and additional yield from the Seattle Well Fields. An evaluation of specific Seattle water right claims, permits, and applications as called for in Washington State Department of Health (WDOH) planning guidelines is included as an appendix to this *2007 Water System Plan*. Forecasts indicate that Seattle does not need to apply for any new water rights within the 20-year planning horizon.

In 2003, the Municipal Water Law (MWL) was enacted, which allows the place of use for a municipal water right to be changed to coincide with the service area described in the municipal supplier's most recently approved water system plan. Through this water system plan, SPU seeks to change the place of use for the Cedar River and Lake Youngs water right claims to the service area described in this plan, as allowed by this provision of the MWL. (Figure 2-1 shows these areas.)

Other significant events regarding water rights have occurred since the *2001 Water System Plan*:

- Ecology granted a certificate for the South Fork Tolt Reservoir on January 17, 2003, which finalizes Seattle's right to store water at the reservoir.

- Seattle applied for a reservoir permit in June 2005 for the ASR project at its two well fields and permits for use of the wells to replace its temporary permits.

- Ecology granted a 27-year extension to the City's diversion permit for the South Fork Tolt River on November 30, 2005.

Firm Yield and Supply Reliability

The firm yield of SPU's current supplies is 171 mgd.

Firm yield is the amount of water that SPU is able to supply system-wide at a given delivery pattern while meeting the supply reliability standard, instream flow requirements, and other system constraints. Firm yield is expressed as an average annual delivery rate in mgd from all sources operated conjunctively. Calculating firm yield for SPU's existing supply sources is critical to ensuring that SPU can meet existing and future demands reliably. The firm yield can be compared to long-term forecasts of water demand to determine when new sources or additional conservation programs need to be online to maintain the desired level of supply reliability. Firm yield calculations are also useful in determining the quantity of water that can be expected from a potential new source of supply.

SPU uses a computer simulation model to calculate the firm yield from its existing water supply sources and potential new water sources. This model is known as the Conjunctive Use Evaluation (CUE) model. The model is used with 75 years of reconstructed historic flow records to produce a system-wide firm yield estimate. SPU's supply reliability standard is 98 percent. Therefore, SPU's firm yield is the amount of water that is assured for delivery in all but the driest 2 percent of years without lowering reservoirs below normal minimum operating levels. The combined firm yield of all SPU supplies is 171 mgd, the same as it was in 2001.

Agreement with Muckleshoot Indian Tribe

In 2000, the City completed the Cedar River Watershed HCP and was granted federal incidental take permits for its water management, hydropower, and land management operations. In 2003, the Muckleshoot Indian Tribe (Tribe) legally challenged the permits and HCP on the grounds that they did not assure sufficient water for fish. In 2006, the City and Tribe reached a legal settlement that addresses Cedar River instream flows and water diversions and also addresses other issues of mutual interest, including past damages to fish runs and access to the municipal watershed. That settlement establishes greater certainty for the region's water supply, supports Tribal treaty rights, strengthens fish protection, and creates a cooperative framework for resolving issues in the future.

Aspects of the agreement that are particularly important to SPU's water resources management include the following:

- Guaranteed instream flows. Whether or not the 50-year HCP continues in force, the City will continue to fulfill all of its commitments in the HCP related to instream flows and related research in perpetuity.

The Muckleshoot Agreement preserves SPU's firm yield while ensuring that sufficient water will be available for instream resources in the Cedar River.

- Limits on Cedar River diversions. There are interim limits, leading to permanent limits, on average annual water diversions to provide certainty that the Cedar River will not be over-appropriated to the detriment of instream resources while preserving SPU's firm yield.

- Transfer of water right. Seattle will transfer the portion of its perfected water right claim that exceeds the permanent annual average diversion limit of 124 mgd to the State Water Trust for the purpose of protecting instream flows.

- Continuing water conservation. Seattle will continue its conservation efforts and include a requirement to implement conservation measures similar to those required of Seattle retail customers in all new wholesale contracts.

Other elements of the settlement agreement address Cedar River sockeye salmon mitigation and Tribal fishery projects; Tribal access to the municipal watershed for hunting, gathering, wildlife management and research, and conducting traditional activities there; a cooperative plan for wildlife management; a 10-year wildlife research program; and transfer of land to the Tribe.

2.3.5 Operations

The surface water supply facilities on the South Fork Tolt and Cedar Rivers are operated primarily for water supply and instream flows, but are also used for hydroelectric power generation and flood management. The reservoirs are drawn down and refilled each year. The groundwater supply facilities at the Seattle Well Fields supplement these sources, if needed. Water resource management and operations have changed since 2001 as a result of SPU's installation of a fish ladder and fish passage facilities at the Landsburg Diversion Dam. SPU has also been experimenting with operational techniques to better manage water temperatures for fish. These operational changes are discussed below, following a brief discussion of how SPU manages seepage from the Masonry Pool to benefit both fish and people.

Controlling Masonry Pool Seepage

As noted previously, some of the Cedar River source water can be lost as a result of seepage through the porous soils of the Cedar moraine on the northern bank of Masonry Pool. This seepage actually provides an overall net benefit to water supply because of the additional storage provided by the moraine aquifer and the timing of water returning to the Cedar River. Recent analysis conducted by SPU found that if seepage from Masonry Pool were completely eliminated, an estimated 24 mgd of firm yield would be lost. Presently, water levels in the lake and pool are managed to minimize moraine embankment instability and the potential loss in water supply yield. These management practices are focused on manipulating the water surface elevation in the Masonry Pool to selectively manage seepage to the moraine. Without these efforts to manage seepage, modeling suggests that SPU's firm yield would be as low as 133 mgd, compared to SPU's actual firm yield of 171 mgd.

Operational Changes Due to Fish Passage

The *2001 Water System Plan* described SPU's efforts to reestablish native salmon populations above the Landsburg Diversion Dam (excluding sockeye salmon given their large numbers and the resulting potential for drinking water quality impacts) as part of Seattle's commitments established by the Cedar River Watershed HCP. SPU began operating its new fish ladder and fish passage facilities on the Cedar River in late summer of 2003, just prior to the return of adult salmon. The HCP also provides for an enhancement of raw water quality monitoring activities to verify previous investigations that projected little or no effects on drinking water quality from passing limited numbers of Coho and Chinook salmon upstream of Landsburg.

The operation of the downstream fish passage facility can affect river flow rates downstream of Landsburg Diversion Dam. Landsburg facility operators are integrating their operating procedures to meet instream flow requirements and river flow management objectives under varying hydrologic and water supply conditions.

Temperature Management at South Fork Tolt Reservoir

Since 2004, SPU has been experimenting with operating the existing reservoir intake gates to draw water for release from different water depths in the South Fork Tolt Reservoir in order to establish whether water quality, especially water temperature, in the South Fork Tolt River downstream of the South Fork Tolt Dam can be improved to benefit instream resources. SPU is continuing to monitor and collect data for analysis.

2.3.6 Maintenance

SPU's water resource maintenance activities focus on the City's watershed dams and particularly on dam safety. The water system includes seven dams located in the Cedar and Tolt water supply systems that are owned by SPU. These dams are maintained to ensure operability and safeguard against damage or failure in large floods, earthquakes, malevolent acts, and general deterioration from aging. Ecology's Dam Safety Section and the Federal Energy Regulatory Commission (FERC) regulate the maintenance of SPU's dams to ensure continued safe performance. Both Ecology and FERC require regular inspections of these dams and related infrastructure, such as spillway gates and dam failure warning systems; inspections that can result in requirements for maintenance work or major capital improvements.

SPU is developing a strategic asset management plan (SAMP) for the major dams that are part of the water supply system. This SAMP will analyze how SPU should maintain and repair the dams and make recommendations as to any renewals of the existing dams or their components. It will also include recommendations regarding elements such as the mechanical and electrical equipment associated with the dams, including the dam failure warning systems.

2.4 Needs, Gaps, and Issues

Needs, gaps, and issues facing the Water Resources business area include the need to appropriately plan for water supply in the face of uncertainty, the need to ensure consistency with other related planning efforts, the need to improve water supply infrastructure, the issue of the optimal operating range of the South Fork Tolt Reservoir, and the lack of a supply management service level. Each of these specific needs, gaps, and issues is discussed in the following section, along with how SPU plans to address them.

2.4.1 Planning for Uncertainty

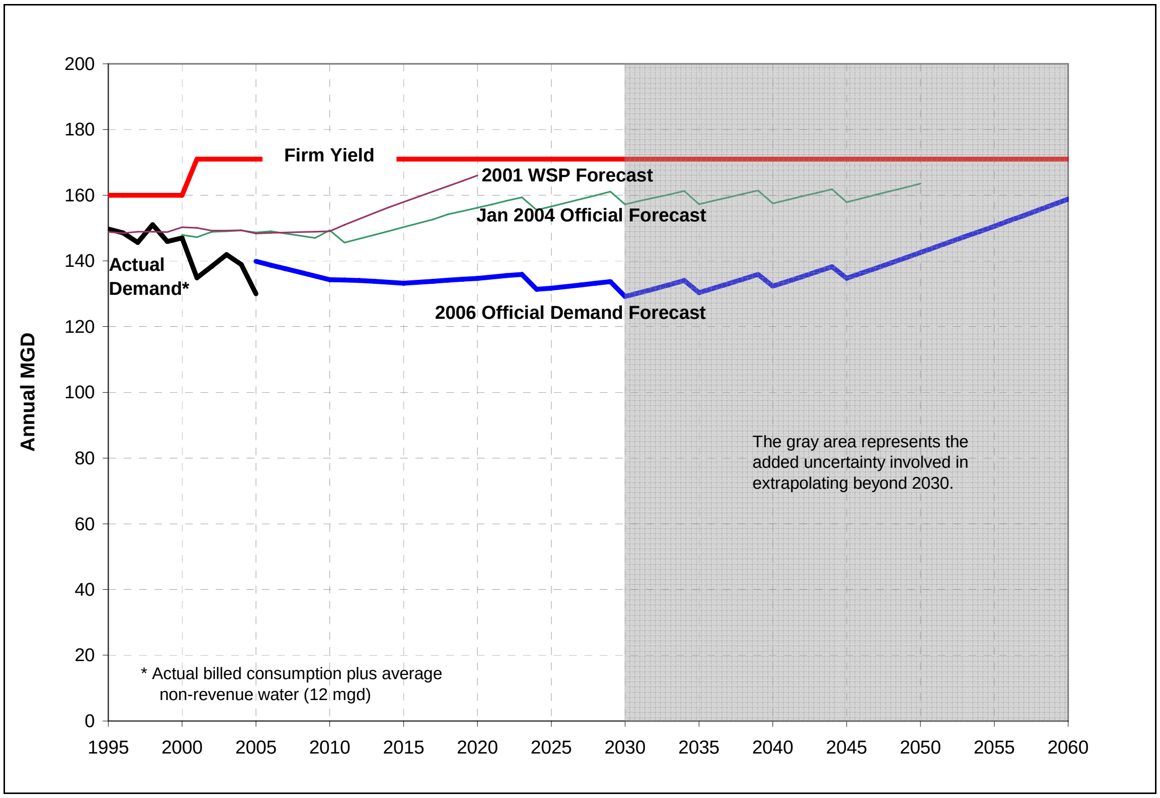
The uncertainties affecting both future water demand and future water supply are considerable. Future water demand is dependent on population growth, income, conservation, weather, and other factors. Future water supply depends on climate, legal and regulatory issues, the feasibility of developing new supplies as needed, and other factors. SPU has developed water demand forecasts and analyzed future water supply alternatives using frameworks that incorporate these relative uncertainties. The results of SPU's analyses are described in the following sections.

Forecasting Water Demand

Long-term water demand forecasting is critical for water system planning. SPU has developed a Demand Forecast Model that incorporates the best features of various model types found in applicable literature. Like simple "fixed flow factor" models, the new SPU model is easy to understand and has relatively modest data requirements. However, like more complex econometric models, the model reflects the impacts of variables such as price, income, and conservation on water use factors over time. This approach takes advantage of past econometric analysis to provide estimates of how price and income can affect demand. SPU's Conservation Potential Assessment (CPA) Model is used to estimate the impacts of plumbing code and programmatic conservation on the water use factors over time.

No new sources of supply will be needed until after 2060 given the firm yield estimate and the official demand forecast.

SPU's official water demand forecast is presented in Figure 2-4. In the official forecast, total water demand is projected to remain essentially flat over the next 40 years. There are two primary reasons for this. One is the impact of conservation programs planned through 2030, and the other is the 5 mgd supply reductions in the CWA block that will occur every 5 years between 2024 and 2045. Once the CWA block has been reduced to its minimum level in 2045, and with the assumption of no additional conservation programs after 2030, the water demand forecast begins rising again, finally reaching current levels by about 2050, and 159 mgd by 2060. Peak demands are also forecasted to remain below historic high levels. Given the current firm yield estimate for SPU's existing supply resources and the official demand forecast, a new source of supply will not be needed until sometime after 2060.



*Note: The increase in firm yield in 2001 is due to the start-up of the Tolt Treatment Facility.

Figure 2-4. SPU's Official Water Demand Forecast

SPU's official water demand forecast is based on a number of assumptions in five key areas:

- Future Conservation Goals and Programs. For many years, SPU has been implementing conservation as a way of extending supplies to meet demand. SPU recognizes, however, that there are numerous other factors that drive the need for conservation programs. After completing an analysis to determine the most reasonable level of investment based on all the drivers for conservation programs, the Operating Board selected a conservation goal of 15 mgd of cumulative savings from 2011 through 2030. These savings are included in the demand forecast as a baseline of savings from conservation. If more water is needed in the future, additional conservation programs would be considered as a way to meet future needs, as indicated in the resource selection policy at the beginning of this chapter.

The 2011-2030 Regional Conservation Program may include both public education to promote behavioral changes and customer incentives for installing water-efficient equipment to promote conservation. The conservation goal includes price-induced water savings from rates.

Table 2-5 shows SPU's water conservation goals for the 6-year water system plan period from 2007 through 2012. These savings include those anticipated from the current regional 1% Program, I-63 SO requirements, and the first two years of the 2011-2030 Regional Conservation Program. The Water Conservation Plan described in the appendix contains an analysis used to set the conservation goal and information related to existing and future programs.

Table 2-5. Water Conservation Goals and Other Savings Average Annual Savings, in mgd

	2007	2008	2009	2010	2011	2012
Programmatic Conservation Goals						
1% Regional Program	1.12	1.12	1.12	1.12		
Seattle Ordinance 120532 (I-63 SO)[1]	0.63	0.63	0.63	0.63	---	---
2011-2030 Regional Baseline Conservation Program	---	---	---	---	0.75	0.75
Total Conservation Goal	1.75	1.75	1.75	1.75	0.75	0.75
Other Savings						
Plumbing Code	0.69	0.66	0.64	0.62	0.60	0.58
Price Savings[2]	0.20	0.20	0.20	0.20	---	---
Total Other	0.89	0.86	0.84	0.82	0.60	0.58
Total Estimated Savings	2.63	2.61	2.59	2.57	1.35	1.33

[1] Savings are from SPU's direct service area and include the "Everyone Can Conserve" program, reclaimed water projects, reservoir covering and other system efficiencies, and conservation investments in City of Seattle facilities.

[2] After 2010, included in 2011-2030 Regional Conservation Program savings goal.

- <u>Block Contracts.</u> The block supply amounts to be provided by SPU to Northshore and CWA are included in the forecast as stated in the contracts. Under the CWA contract, Seattle will provide a fixed block of 30.3 mgd to CWA through 2023. The block will be reduced by 5 mgd in 2024 and by another 5 mgd in 2030. Additional 5 mgd reductions will occur every 5 years thereafter through 2045, leaving a final block of 5.3 mgd. This has been incorporated into the new forecast, resulting in the "saw tooth" shape.

- Potential New Wholesale Customers. As part of this planning effort, SPU contacted other utilities in its service area to determine if there are potential new customers that may turn to Seattle to meet their future demands. Three utilities indicated interest in being included in SPU's planning: the City of North Bend, the Sallal Water Association, and Ames Lake Water Association. SPU has been actively working with North Bend and Sallal to develop a way to meet their water supply needs while protecting instream resources. Demands for these two purveyors and Ames Lake are included in the SPU demand forecast.

- New Wholesale Contracts. While most of SPU's wholesale customer agreements are in effect until 2062, eight utilities remain under 1982 contracts that expire December 31, 2011. These eight wholesale customers include the Cities of Bothell, Edmonds, Duvall, and Renton, Water Districts 49, 90, and 119, and Lake Forest Park Water District. SPU intends to continue to provide wholesale water to these agencies as needed and will negotiate terms and conditions for new wholesale agreements based on their needs while protecting the interests of other SPU customers. Some of the key issues that would be discussed in the development of new contracts include: (1) contract term, (2) water quantity, (3) costs of water and transmission, (4) conditions of service, (5) roles and responsibilities related to ensuring water quality standards are met, (6) participation in conservation programs, (7) roles related to planning and emergency response, and (8) participation on the Seattle Water Supply System Operating Board. If agreements cannot be reached prior to the expiration of the current contracts, SPU will continue to supply water to those agencies at a rate SPU considers appropriate for the level of service and certainty provided.

The Environmental Block is water dedicated to environmental benefits for salmon.

- Environmental Block. Unlike the 2004 official demand forecast, the set-asides for the Environmental Block are *not* included as a component of water demand in the current forecast. The Environmental Block, as defined in the I-63 Settlement Ordinance, is water dedicated to environmental benefits for salmon that increases over time from 2 mgd in 2001 to as much as 12 mgd in 2015. This commitment will now be met through the 2006 agreement with the Muckleshoot

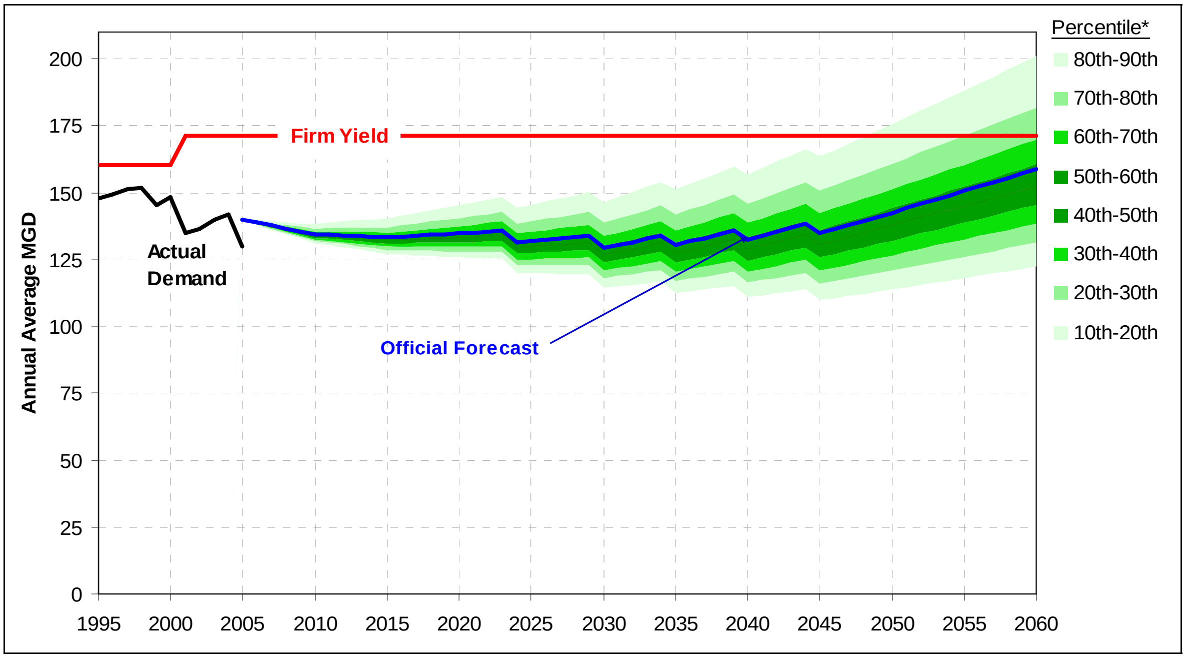
Indian Tribe, in which the City has agreed to leave 20 mgd of its perfected water right in the Cedar River.

- Non-Revenue Water. Combined transmission and Seattle distribution system non-revenue water is assumed to decrease from 12 mgd to 9 mgd between 2000 and 2015 as in-city reservoirs are covered. From that point on, however, non-revenue water is projected to gradually increase, reaching 15.5 mgd by 2060. This increase is expected to be caused by the increasing number of leaks that are likely to occur as the distribution system ages.

Uncertainty in Demand Forecast. Much uncertainty surrounds the forecast of water demand. The official forecast is itself based on forecasts of income, water prices, households, and employment–all subject to uncertainty. Additional uncertainty surrounds the forecast model's assumptions about price and income elasticities, and future conservation. Uncertainty was modeled by specifying probability distributions around each source of uncertainty. These distributions became inputs to an aggregate uncertainty model employing a Monte Carlo simulation to characterize uncertainty around the official demand forecast.

The results of the Monte Carlo simulation are displayed in Figure 2-5. The green bands indicate the range of uncertainty around the official forecast with each band representing a 10 percent change in probability. For example, the bottom of the lowest band represents the 10th percentile. That means it is estimated that there is a 10 percent chance that actual demand will be below that point and, thus, a 90 percent chance it will be above. The top band is the 90th percentile which corresponds to an estimated 90 percent probability that actual demand will be below that point.

Taking demand uncertainty into consideration, there is still a 70 percent probability that a new source will not be necessary before 2060. The uncertainty analysis also implies a 90 percent probability that existing sources will be sufficient to meet demand through at least 2048.



*Note: Percentiles represent the probability that actual demand will be less than the value shown. Ranges reflect uncertainty in projected household, employment, price and income growth, price elasticity, income elasticity, and conservation. Note that the Official Forecast is at about the 57th percentile.

Figure 2-5. Uncertainty in Water Demand Forecast*

This approach to evaluating uncertainty is useful when considering the possibility of future supply reductions. One pessimistic scenario involves a future 20-mgd loss in supply due to climate change or other factors, reducing firm yield to 151 mgd. Even with a 20-mgd loss in supply, there is still enough supply to meet expected demand (i.e., the official demand forecast) through the year 2055. In fact, SPU estimates an 80 percent probability that demand will remain below 151 mgd until 2043.

Evaluating Supply Alternatives

SPU uses its Water Supply Planning Model to look at alternative future supply strategies and incorporates asset management principles. This model was used to look at traditional sources of supply, water conservation, reclaimed water projects, and to a lesser level of detail, desalination. The following paragraphs describe the water supply planning model, the alternatives evaluated, evaluation results, and the recommendations from the model.

Water Supply Planning Model Description. With SPU's focus on asset management and in recognition of the uncertainties surrounding future supplies and demand, SPU created a modeling framework to explore water supply strategies[2]. The framework allows SPU to make supply investment decisions based on lowest life-cycle costs while considering risks and the triple bottom line. This model consists of two components:

- Decision Tree Model. The decision tree model computes levelized unit costs in current dollars of different supply investment strategies based on various uncertainties and scenarios. The strategies consider the source to be developed and when it would come on line. This model is used to explore source development uncertainties, loss of supply due to legal/regulatory changes, climate change and variability impacts, and cost uncertainties.

- Value Model. The value model merges the source selection criteria approved by the Operating Board with the SPU risk assessment framework to create a tool for evaluating the non-monetary values, benefits, and impacts associated with supply options, including conservation packages. Each supply alternative is scored for public/political acceptability, environmental impacts, legal/regulatory issues, public health/drinking water quality, social/lifestyle impacts, ease of development, and operational reliability and robustness. These scores are then weighted to produce a single value score.

The results of both models are considered in selecting a supply strategy.

Evaluation of Traditional Supply Sources. Traditional supply alternatives were evaluated using the Water Supply Planning Model. The additional supply and cost estimates for these supply alternatives, which were presented in the *2001 Water System Plan*, are summarized in Table 2-6.

Evaluation of Reclaimed Water Projects as a Supply Source. Five studies have been performed in recent years by Seattle or King County to investigate the costs and benefits of using reclaimed water as an additional source of supply. As part of this *2007 Water System Plan*, SPU evaluated in more detail the most promising potential reclaimed water projects in Seattle's retail service area that had been identified in the previous studies. The alternative evaluation, included as an appendix, looked at the quantity of water that each alternative project could produce, the

[2] *SPU Water Supply Planning Model*, April 2006, prepared for Seattle Public Utilities by CH2M HILL.

Table 2-6. Summary of Traditional Supply Alternatives

Alternative	Description	Additional Firm Yield	Design and construction cost (in millions)	Annual fixed operating cost (in thousands)
Chester Morse Lake Dead Storage	Construction of a pump station to access dead storage to 1502' on a more regular basis as a part of normal supply.	20-39 mgd[1]	$26.2	$341
Lake Youngs Drawdown	Use of storage at Lake Youngs and additional diversions from Cedar River to increase firm yield. Addition of filtration at Cedar Treatment Facilities.	20 mgd[1]	$164.2	$2,236
Additional South Fork Tolt Reservoir Drawdown	Drawdown of reservoir to different elevations depending on temperature and turbidity restraints. May require changes at Tolt Treatment Facility.	4 mgd (1695') 8 mgd (1660')	$0.31 (1695') $19.3 (1660')	$146 (1695') $496 (1660')
North Fork Tolt River Diversion	Construction of a small diversion on the North Fork Tolt in addition to drawdown of the South Fork Tolt to elevation 1660' and installation of Tolt Treatment Facility sedimentation basins.	8-40 mgd[2]	$179.3	$2,267
Snoqualmie Aquifer	Development of the Snoqualmie Aquifer with new filtration plant, pump station, and an interconnection to SPU's Tolt pipeline.	16 mgd[3]	$114.9	$1,860

[1] Conceptually, a portion of this additional water supply could be used to augment instream flows on the Cedar River.
[2] Depends on instream flow requirements on the main stem of the Tolt River.
[3] Assumes all of firm yield addition is available to SPU.

benefits or value of implementing the project, and the costs of producing the reclaimed water. The results of that evaluation indicate that the unit cost of the water obtained from these reclaimed water projects are significantly higher than the cost of obtaining additional water from more traditional sources.

In addition to the high unit costs for the reclaimed water projects, runoff from the golf course irrigation alternatives would likely flow towards salmon streams, thereby raising environmental concerns. Environmental concerns were factored into the value score for these projects. A summary of the results of the reclaimed water evaluation are shown in Table 2-7.

The *Draft White Paper, Reclaimed Water Backbone Project, Version 3.0* (March 2006, King County Department of Natural Resources and Parks, Wastewater Division) identified twelve potential customers for reclaimed water in the City of Shoreline service area from the Brightwater Reclaimed Water Phase III Conveyance System. The City of Shoreline, where residents west

Table 2-7. Summary of Reclaimed Water Project Alternatives

Alternative	Description	Average Additional Supply	Construction cost (in millions)	Annual operating cost (in thousands)
Catholic Calvary Cemetery	Construction of a membrane bioreactor (MBR) plant to treat wastewater from SPU sewers and supply reclaimed water to irrigate the Catholic Cemetery.	0.04 mgd	$4.2	$74
Jackson Park Golf Course*	Construction of transmission pipeline from the Brightwater reclaimed water backbone pipeline at the Ballinger Way Portal to supply reclaimed water to the Jackson Park Golf Course.	0.1 mgd	$7.2	$180
Urban commercial core/Myrtle Edwards Park	Construction of an MBR plant at Myrtle Edwards Park to treat wastewater from SPU sewers and construction of a distribution system grid in the downtown area to supply reclaimed water to new developments.	0.4 mgd	$38.2	$175
West Seattle Golf Course (A)	Construction of an MBR plant to treat wastewater from SPU sewers and supply reclaimed water to irrigate golf course.	0.05 mgd	$3.0	$70
West Seattle Golf Course (B)	Construction of an MBR plant to treat wastewater from King County sewers and supply reclaimed water to irrigate golf course.	0.06 mgd	$5.5	$107

* Assumes Jackson Park Golf Course is using SPU water instead of its own wells.

of Interstate 5 are SPU retail customers, currently has no specific plans to implement any of those reclaimed water projects. SPU will rely on the City of Shoreline to initiate further investigation of any reclaimed water opportunities within its city limits.

Evaluation of Conservation as a Supply Source. The Water Supply Planning Model was also used to analyze water conservation as a possible source of future supply. Using data from SPU's CPA updated in 2004 and 2006, 10-year programs of varying levels of savings and costs were evaluated. Results are presented for a 10-year program achieving 4 mgd of cumulative savings at an annual cost of $6 million. Although this information is based on conservation measures identified in the 2006 CPA, it is likely that improvements in technology will decrease program costs or introduce new measures that would produce more savings at lower costs. As this information becomes known, it can be incorporated in the model and included in the evaluation of source options.

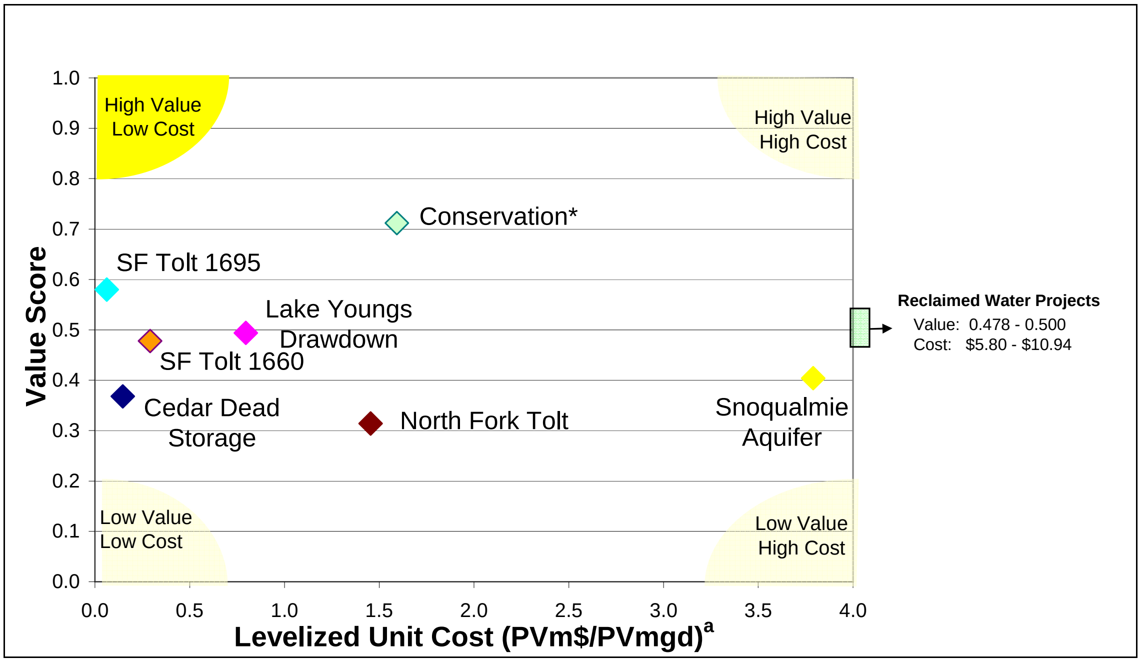
Evaluation of Desalination of Seawater as a Supply Source. In addition to evaluating traditional new supply sources, investigating reclaimed water sources, and analyzing conservation, SPU recently studied advances in desalination technology and their associated costs. Desalination technology has improved, and unit costs for desalinated seawater are becoming more competitive with other supply options around the country. The construction of a 25-mgd desalination plant in Tampa Bay, Florida, has raised awareness that the life-cycle costs of producing desalinated water could be as low as $2.00 per hundred cubic feet. However, desalination costs depend greatly on the specific location of the desalination facility, and a full evaluation of a desalination project would entail selection of a specific treatment source and site.

Water Supply Planning Model Results. The relative values of each supply alternative were scored against each other to determine which alternatives had the highest value compared to their costs. In this framework, alternatives with relatively lower costs and higher value are preferred over others. Figure 2-6 graphically displays the findings for all alternatives except desalination, which was not developed to a sufficient level of detail to accurately estimate costs and benefits.

The results of the evaluation for each of the future water supply alternatives are summarized briefly below:

- <u>Traditional Supplies.</u> The model results indicate that the lowest cost and highest value alternative is limited drawdown of South Fork Tolt Reservoir from 1,710 feet to 1,695 feet. The higher cost and lower value alternatives include the North Fork Tolt diversion and Snoqualmie Aquifer. Cedar Dead Storage, South Fork Tolt additional drawdown to 1,660 feet, and Lake Youngs drawdown are all within a range of acceptable values and costs.

- <u>Reclaimed Water Projects.</u> The reclaimed water analysis shows that reclaimed water projects, while having a higher value score than the Cedar Dead Storage, North Fork Tolt Diversion and Snoqualmie Aquifer projects, are much more costly than the South Fork Tolt Reservoir limited drawdown, conservation, and the other traditional supply alternatives analyzed. Because lower cost reclaimed water projects may present themselves in the future, SPU will continue to watch for situations where reclaimed water projects may be preferred over other available options.



[a] Calculated assuming all sources on line in 2050.
[*] 4 mgd conservation program may begin in 2045 and phase in over a 10-year period.

Figure 2-6. Value Score vs. Levelized Unit Cost for Supply Alternatives

- Conservation. Conservation provides the highest value of all alternatives examined, and should be included in the evaluation of future supplies along with Cedar Dead Storage, South Fork Tolt additional drawdown to 1,660 feet, and Lake Youngs drawdown. As mentioned previously, lower cost conservation technologies may be developed prior to the time when a new supply source is needed; future supply analyses should use up-to-date information on conservation measures.

- Desalination of Seawater as a Supply Source. Using the 25-mgd desalination plant in Tampa Bay, Florida, as an example, desalination could have levelized unit costs that are roughly the same as South Fork Tolt additional drawdown to 1,660 feet and Lake Youngs drawdown, with a value score slightly below these alternatives. However, desalination costs are extremely site sensitive, and the Tampa Bay result should be considered as only a rough estimate. As additional water supplies are needed in the future, SPU may consider conducting a desalination feasibility and siting study to lay out conceptual plans for a desalination facility at a particular site so that a more complete evaluation of costs and environmental concerns can be developed. Meanwhile, SPU plans to stay abreast of the technological and cost-savings advances in desalination and new desalination projects around the nation.

Despite the potential for declines in supply due to future climate change, there is no need for additional source development at this time.

Supply Investment Strategy. As described earlier, the Demand Forecast Model indicates that due to SPU's estimated ability to meet demand with a high (70 percent) certainty until 2060, there is no need for additional source development at this time. Even if 20 years are needed to develop a source, significant investments in new supply planning need not occur for several decades. Therefore, SPU's supply investment strategy is as follows:

- Plan for meeting future demand based on the official forecast, which represents the best estimate of known factors that influence demand and includes those demands that SPU will need to meet in the future.
- Update analysis as significant changes are made to demand forecasts or yield estimates or when more information is obtained for key uncertainties.
- Revisit forecasts at least every six years during water system plan updates.
- Collaborate with regional planning partners.
- Keep the current menu of supply options open and review if/when significant decisions need to be made about investing additional funds into such supply options.
- Evaluate South Fork Tolt Reservoir levels of drawdown below elevation 1,710 feet that could be used for potential additional future supply by continuing to manage operations at the Reservoir to limit temperature impacts downstream of the dam, and collect data on temperature and turbidity at low reservoir conditions.

2.4.2 Consistency with Other Planning

In planning to meet future demand, it is necessary to coordinate with other planning efforts to ensure consistency. Such plans include the King County coordinated water system plans, the water system plans of SPU's wholesale customers, the *King County COMPLAN*, Seattle's *Comprehensive Plan*, water system plans of adjacent water purveyors, King County's *Regional Wastewater Services Plan*, and watershed plans. Each of these plans and their relevance to SPU's water resources and water system planning is described below.

Coordinated Water System Plans

Three of the four coordinated water system plans (CWSPs) in King County are for areas served by the SPU regional water system, including east King County, south King County, and Skyway/Bryn Mawr. (The fourth CWSP is for Vashon.) SPU worked with the regional water associations responsible for developing those plans to ensure coordination with SPU planning. SPU participates in the development and updates of these plans to varying degrees, depending on the extent to which SPU's service area overlaps with the CWSP area. SPU staff also maintains regular contact with regional water associations on issues related to SPU's *Water System Plan*.

There has been some discussion of CWSPs being updated to reflect current work by CWA to pursue Lake Tapps as a new source of supply. Alternatively, King County may initiate a new CWSP with CWA. Should the existing CWSPs be updated, SPU would coordinate with regional water associations as it has in the past in the development of such updates. If King County and CWA initiate a new CWSP, SPU would work with CWA to ensure consistency between the Seattle regional plan and any new plan that might be developed.

Wholesale Customers' Individual Water System Plans

As SPU's wholesale customers update their water system plans for their own water supply and distribution systems, SPU staff coordinates with them so that their water system plans maintain consistency with SPU's *Water System Plan*. For most customers, this includes SPU review of their draft plans in the following key areas:

- Assumptions about the quantities and pressures available from SPU transmission lines.
- Demand forecasts to ensure consistency of population forecasts among Seattle and its wholesale customers.
- Responsibilities that the customer shares with SPU, such as distribution system water quality monitoring.
- Conservation programs.

SPU does not comment on water system plan demand forecast and conservation elements for wholesale customers now purchasing water through the CWA because SPU is not involved with CWA planning in these areas.

SPU participates in and coordinates with other regional planning efforts to ensure consistency.

Since the *2001 Water System Plan*, SPU has provided input and comments on water system plans from Bothell, Coal Creek, CWA, Kirkland, Redmond, Skyway, Soos Creek, Tukwila, and Water District 20. SPU will continue working closely with wholesale customers to coordinate regional water supply planning activities.

King County COMPLAN

Most of SPU's service area is within incorporated areas of King County. A very small part of its retail service area is in unincorporated King County. SPU's *2007 Water System Plan* aims to be consistent with the *King County Comprehensive Plan* (*COMPLAN*) to be sure that growth targets within the SPU service area match the availability of water supply to serve related demand.

The 2004 update of the County *COMPLAN* describes the urban growth boundary as being the one adopted by the County Council in 1994. This has been factored into the demand forecast.

City of Seattle's Comprehensive Plan

Seattle's *Comprehensive Plan* relates to this water system plan in regard to water distribution issues. Planned population increases and changes in land uses are important to how SPU conveys water throughout the distribution system.

Although minor changes have occurred more often, the last major update to the *Comprehensive Plan* was in 2004, as a result of the 10-year review required by the Growth Management Act. The major change affecting the water distribution system was the designation of South Lake Union as Seattle's sixth urban center. The other five urban centers are Downtown, First Hill/Capital Hill, Northgate, University Community, and Uptown Queen Anne. The Utilities Appendix of that plan concludes that improvements to the existing distribution system will be needed to support growth over the 20-year life of the *Comprehensive Plan*, in the urban centers and elsewhere. It assumes that most of these improvements will be paid for by developers and not through rates.

Adjacent Purveyors

A number of water purveyors within SPU's water service area and adjacent to existing SPU wholesale customers are not themselves current SPU customers. These include Water District No. 54, Lakehaven Utility District, City of Kent, City of Auburn, Water District No. 111, Mirrormont, Northeast Sammamish Water District, Union Hill, Ames Lake, Carnation, Fall City, and several other smaller purveyors. When water system plans for these systems are received, SPU reviews them for compatibility and consistency in areas such as assumptions about water demand forecasts, transmission needs, and water quality issues. None have been received since 2001.

Purveyors Beyond the Boundaries of SPU's Service Area

As a regional water supplier, SPU is an active participant in the update of the *2001 Central Puget Sound Water Supply Outlook*, produced by the Central Puget Sound Water Suppliers' Forum for the three-county region of Snohomish, King, and Pierce Counties. Being involved in this process helps ensure coordinated water supply planning throughout the region and between the three major utilities in central Puget Sound: Everett, Tacoma, and Seattle. It also highlights opportunities for efficiencies that can help to reduce impacts from utilities.

In addition, SPU is engaged in a regional planning effort initiated by King County as a way to produce good technical information that will assist in the planning activities of the utility. The linkage between these two planning efforts helps in understanding water resource issues related to providing water for both people and fish, and supports planning processes throughout the region.

Regional Wastewater Services Plan

In 2004, King County published an update to its *Regional Wastewater Services Plan* (*RWSP*). The *RWSP* contains proposals for disposal of the region's wastewater, including using reclaimed water as a new source of water supply. Several possible uses for reclaimed water to offset demand for potable water are identified in the *RWSP*. SPU participated in the development of the *RWSP* and continues to work with the County in assessing the potential for reclaimed water, developing pilot projects, and other efforts as part of the King County reuse task force.

Watershed Plans

The only watershed plans in the SPU retail service area are Chinook Salmon Conservation Plans for the Cedar River/Lake Washington/Lake Sammamish Watershed (WRIA 8) and the Green/Duwamish and Central Puget Sound Watershed (WRIA 9), which were finalized in 2005. This watershed planning was within the framework of RCW 77.85, Salmon Recovery. This is not one of the types of watersheds plans for which a water system plan must show consistency according to the Municipal Water Law.

The 50-year Cedar River Watershed HCP that SPU developed was agreed to with federal and state resource agencies in 2000 and is now being implemented. SPU continues to be in compliance with the HCP.

2.4.3 Infrastructure Needs and Improvements

SPU maintains its water resources facilities for safe and reliable operation to ensure water supply is available for its customers. Three infrastructure projects, Chester Morse Lake dead storage facilities, Cedar moraine safety improvements, and Landsburg flood passage improvements, comprise the major capital improvement focus for SPU's Water Resources business area. These projects are described below.

Chester Morse Lake Dead Storage Facilities

The Chester Morse Lake pumping plants are currently used to access dead storage when water levels in the lake are low, such as during droughts. Pumping provides additional flow to the Masonry Pool and the Cedar River to meet customer needs and instream flow requirements during drought or other supply emergencies.

Stop logs are long wooden structures that are used like a dam to contain water in a pond or pool.

In recent years, maintenance work and capital improvements have been completed to ensure operability and restore flow capacity of the pumping plants and associated facilities. This work included deepening the outlet channel, modifying the discharge dike to increase its height and allow use of stop logs, improving the discharge pipes, testing and replacing electrical cable, and making electrical safety improvements. Even with these improvements, concerns remain over the reliability and readiness of these facilities. Of particular concern is the long-term stability of the outlet channel and its flow capacity. Infilling of the outlet channel has resulted in the need to begin pumping operations sooner to supplement gravity flow to the Masonry Pool. Also of concern is the long lead time needed to mobilize the pumping plants prior to actual use. Up to two months are needed to ready the plants, which can lead to costly efforts that later prove to be unnecessary when plants are then not subsequently needed or put to use.

SPU is working on preliminary engineering studies to evaluate options and recommend the most cost-effective and reliable system for delivering water from dead storage during droughts and other emergencies. Options under analysis include modifications to the existing system, construction of a new pump station and discharge pipelines, and tunnel options. Various options for stabilizing the outlet channel are also being evaluated. One promising option is to replace the system with a land-based pump station and new pipeline that would discharge water at the downstream end of the outlet channel.

Cedar Moraine Safety Improvements

Cedar moraine safety studies were initiated by SPU as required by the Department of Ecology Dam Safety Section in response to recommendations in a March 2000 consultant safety inspection of the Masonry Dam and associated Masonry Pool and moraine. The objectives of the study were to determine the stability of the moraine slopes under both static and seismic conditions and to improve the monitoring of the moraine. The geotechnical investigations and stability analyses of the moraine slopes were completed in 2006. The results of the studies showed that one slope in the area of West Boxley Creek appeared to have the potential of a groundwater burst flood event that could cause unacceptable damage during a large earthquake. This result was based on a conservative assumption, which SPU may choose to verify by field investigation before committing to an improvement. Assuming that a remedial measure is required, the most likely improvement would be to install three horizontal drainage tunnels extending about 100 feet into the face of the slope. Water from the drains would be guided towards natural channels in the area and would not change the flow regime. Improvements would also be made to the monitoring of the moraine as recommended by the consultant. Whatever approach is taken, it will be implemented so as to satisfy state dam safety criteria.

Landsburg Flood Passage Improvements

Since the Cedar River flooded in Fall 1990, there have been concerns about flood debris, such as large, fallen trees uprooted during high flows, blocking the spillway gates at Landsburg

Diversion Dam during major floods. SPU has completed preliminary engineering and life-cycle cost analyses to improve the flood passage capabilities at the dam. The selected alternative consists of replacing two existing spillway gates with one larger, radial gate and installation of a trash rake system for debris handling. After completion of these improvements, SPU crews will be better able to remove logs and other flood debris from the face of Landsburg Dam. This will reduce the risk of overtopping of the dam during large flood events, which could potentially cause severe erosion of the embankments and place the dam at risk of failure.

2.4.4 South Fork Tolt Reservoir Studies

SPU has traditionally operated the South Fork Tolt Reservoir to serve its customers based on historical operator experience and perceived knowledge of the reservoir's operational constraints. In an effort to better understand the actual constraints of the system and the potential costs, benefits, and risks for pushing those boundaries, SPU is studying the operations of the South Fork Tolt Reservoir.

There is potentially significant benefit to expanding the historical operating range of the reservoir. To do that, SPU needs to conduct studies and analyses to increase the understanding of the constraints and environmental issues associated with reservoir operations. Topics to be potentially included in this comprehensive analysis of South Fork Tolt Reservoir operations are drawdown below elevation 1,710 feet; raising the spillway ring gate to allow higher summer storage volumes; dynamic rule curve application for flood season operations; reservoir temperature and turbidity management; water quality evaluation of releases to river and treatment plant; drawdown/refill strategies; flood management; and instream flow.

2.4.5 Supply Management Service Level

In addition to needed infrastructure and operational studies, SPU lacks a supply management service level that specifies an upper limit for how often customers should expect curtailments. It is a common misconception that with demand below firm yield, SPU should only rarely need to ask customers to curtail water use. This would be true if water managers knew in advance how dry each year was going to be. However, precipitation is inherently difficult to forecast, and thus, stream flows and reservoir inflows are difficult to forecast. Water managers do not know how much precipitation will occur during a year, nor do they know when the fall rains will return. In years that begin badly, with low snow pack and/or very dry or warm spring weather for example, responsible water supply management dictates early action so that possibly needed savings can be accomplished during the high water use seasons of spring and summer. Such actions may end up being overly conservative if the rains return normally in the fall. This inability to accurately predict the coming season's precipitation patterns or totals produces the apparent paradox of having occasional water shortage advisories or curtailments at the same time that considerable long-term excess supply exists.

This paradox is a result of how water managers must operate their systems year-to-year. When water managers make decisions in the spring, they do so without the knowledge of what the summer or fall will bring in terms of temperatures and particularly rainfall. Those decisions, therefore, reflect the level of risk SPU is willing to take that reservoirs will not go below normal minimum levels in the fall. This risk exists regardless of demand levels and firm yield. As a result, there may be more curtailment events than would be needed if the ability to reliably predict future water conditions existed.

To provide a measure of frequency of water advisory or curtailments that customers may expect, SPU will define and develop a supply management service level. This service level will also characterize how well the supply system is managed in any given year. Historic curtailment frequencies, current demand levels, and operational capabilities will be some of the key elements considered in the service level development process. While developing this service level, SPU will consider how new or improved management strategies, including enhanced modeling and forecasts and deployment of alternative supplies and emergency reserves, may be used to help limit the frequency of customer curtailments.

2.5 IMPLEMENTATION/ACTION PLAN

In the absence of a need to develop new water supplies, SPU's implementation/action plans in the Water Resources business area focus on continuing conservation efforts, updating the water supply analysis, studying the impacts of additional drawdown of the South Tolt Reservoir, improving infrastructure reliability, exploring operational flexibility to optimize existing supply, developing a supply management service level, and continuing to coordinate with other regional providers and planners. A summary of the implementation/action plan for the Water Resources business area is as follows:

- Continue to implement water conservation efforts including the Regional 1% Program and the City of Seattle I-63 SO, and prepare to implement measures to meet the 2011-2030 Regional Conservation Program goals.

- Plan to meet future demand based on the official forecast, which represents the best estimate of factors that influence demand and includes those demands that SPU needs to provide for in the future; update the analysis as significant changes are made to demand forecasts or yield estimates, or when more information is available regarding key uncertainties, such as the potential impacts of future climate change and climate variability, and supply alternatives, such as reclaimed water and desalination; revisit the analysis at least every six years during water system plan updates.

- Learn more about what level of additional drawdown the South Fork Tolt Reservoir can accommodate to support additional future supply; understand the potential impacts of increased drawdown on turbidity and temperature downstream of the dam by collecting temperature and turbidity data.

- Complete infrastructure improvements:

    - Evaluate options and recommend the most cost-effective and reliable system for delivering water from Chester Morse Lake dead storage during drought conditions and other emergencies.

    - Complete remedial work and monitoring improvements to address Cedar moraine safety issues, as appropriate.

    - Implement the Landsburg Dam flood passage improvements.

- Develop adaptive management strategies that boost the system's operational flexibility and optimize existing water supply to enhance response to a wide range of varying supply/demand conditions (year-to-year hydrologic variability, potential future impacts of climate change and climate variability, etc.).

- Define and develop a supply management service level; consider how management strategies, including improved modeling and forecasts and deployment of alternative supplies and emergency reserves, may be used to help limit the frequency of customer curtailments.

- Continue to coordinate with regional water planning partners.

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